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FOREST PEST MANAGEMENT

A SURVEY OF ASPEN DISEASES ON THE NICOLET AND OTTAWA NATIONAL FORESTS

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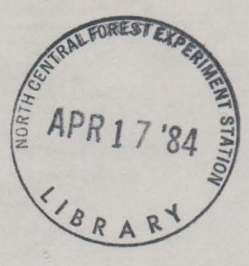

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ABSTRACT

A total of 1,476 live aspen trees were examined to determine the most important diseases in 53 stands on the Nicolet National Forest Wisconsin, and the Ottawa National Forest, Michigan. White trunk rot was the most common disease, infecting an average of 7 percent of the trees sampled. Incidence of this disease increased with stand age from about 3 percent in stands 20 to 39 years old to 16 percent in stands 60 or more years old. About 10 percent of the sampled trees were dead; stem breakage was the most prevalent cause of death.

A SURVEY OF ASPEN DISEASES ON THE NICOLET AND OTTAWA NATIONAL FORESTS

Introduction

Quaking aspen (Populus tremuloides Michx.) and bigtooth aspen (P. grandidentata Michx.) are important commercial tree species in the Lake States. Diseases that affect these species can substantially reduce timber volume each year. Although several species specific disease surveys have been conducted (Anderson 1964, Graham et al. 1963, Marty 1972), the overall importance of aspen diseases in the Lake States has not been determined. In 1981, diseases were surveyed in aspen stands more than 20 years of age on the Superior National Forest, Minnesota (Walters 1982). This report summarizes results of similar surveys done in 1983 on the Nicolet National Forest, Wisconsin, and the Ottawa National Forest, Michigan. Results of these three surveys will provide an indication of the major aspen diseases in stands 20 years or older.

Objective

The purpose of this survey was to determine the importance of aspen diseases on the Nicolet National Forest, Wisconsin, and the Ottawa National Forest, Michigan.

Methods

Fifty-three aspen stands on the Nicolet and Ottawa National Forests (28 on Nicolet and 25 on Ottawa) were randomly selected for sampling. Stands were stratified by age into three classes: 20 to 39 years, 40 to 59 years, and 60 years or older. No stands less than 20 years old were sampled. The number of

stands sampled in each age class was directly proportional to the total number of acres in the age class.

Two 0.1 acre circular plots (r=37.2 ft.) were established from 1 to 8 chains apart in each stand. All aspen greater than 2.0 inches d.b.h. were sampled on each plot. Diameter was measured and visible diseases or wounds were recorded for each live tree sampled. Diameter at breast height and cause of death were determined for trees that had died recently (mostly intact bark and not easily pushed over). Site index was obtained from stand examination records. Approximate species composition was noted for each plot.

Results and Discussion - Nicolet National Forest

On the Nicolet National Forest, 5 stands were sampled in the 20 to 39 years age class, 19 stands in the 40 to 59 years class, and 4 stands in the 60 years or older class. A total of 827 aspen trees were examined on 56 plots in 28 stands. Nineteen stands had quaking aspen and nine had both quaking and bigtooth aspen. Basic stand conditions are summarized in Table 1. Basal area (BA) of living trees ranged from 24 to 133 square feet per acre and increased from the younger to older age classes. Basal area of aspen was low in some stands because of the presence of several other tree species. Site index ranged from 53 to 90, but the average was similar for each age class.

Disease Incidence on Live Trees

Disease incidence was not related to species composition or site index

(Table 2). Overall disease incidence was low for all stands combined. In the 20 to 39 years age class and the 40 to 59 years age class the most common diseases were hypoxylon canker (Hypoxylon mammatum (Wahl.) Mill.), white trunk rot (Phellinus tremulae (Bond.) Bond. et Boriss), and dead tops. In the older age class, nectria canker (Nectria galligena Bres.), white trunk rot, and seams were most common.

Incidence of white trunk rot (based on presence of conks) increased with stand age from 3 percent to 6 percent to 14 percent in the three classes. Other studies have documented this relation between trunk rot and stand age. Stand breakup due to white trunk rot usually begins at about 45 to 50 years of age (Anderson and Schipper 1978). Generally, the number of trees with white trunk rot decay is about two times that of trees with conks on them (Ostry and Walters; In press). Thus, about 28 percent of the trees 60 years or older probably contain some decay.

Hypoxylon canker infected more than 10 percent of the trees in five 40 to 59 year old stands (stands 138-15, 44-43, 36-17, 21-8, 36-24). These trees will probably break off or die from girdling within the next 10 years. Nectria canker was most common in stands 60 years or older and infected more than one-third of the trees in one stand (stand 129-37). The cause for the abnormally high incidence of nectria canker in this stand is unknown. Although this canker seldom kills trees directly, infected trees are often predisposed to wind breakage. The incidence of seams increased with stand age from 0 in the youngest age class to 10 percent in stands 60 years or older. The presence of a seam on a tree often indicates rot behind it, so most of these trees will be defective. Trees with dead tops ranged from 1 to

5 percent, with an average of about 3 percent for all age classes combined. About two-thirds of the dead tops were caused by hypoxylon canker.

Disease Incidence on Dead Trees

Nine percent of the sampled trees were dead. Tree mortality was highest in the youngest age class (12 percent), decreased in the 40 to 59 years class (7 percent), and increased slightly in the 60 years or older class (9 percent). Only the difference in mortality between the youngest and middle age class was significant (P=0.05). In most stands, dead trees had a smaller average diameter than live trees. As in other studies (Anderson and Martin 1981), many of the smaller trees apparently died from suppression. Although several other diseases were identified, the only pathogen commonly associated with dead trees was hypoxylon canker. The following tabulation provides a summary of mortality factors in each age class:

		Cause of Death				
Age Class	No. Dead Trees	Hypoxylon Canker	Windthrow	Broken Off	Other	Unknown
years		percent*				
20-39	28	29	7	39	11	14
40-59	37	35	5	38	5	14
≥60	9	11	11	56	0	22
Total or Average	74	28	7	41	7	15

* Totals may not equal 100 percent due to rounding.

The most prevalent cause of mortality was stem breakage. Trees were broken off at various heights and in most cases the breaks were not associated with an identifiable disease. Usually, we could not determine whether the tree broke off before or after it died, so this category may contain trees

that actually died from other unidentifiable causes and were subsequently broken off. Tree mortality caused by hypoxylon canker was least common in the $\geq$ 60 years age class. In the 40 to 59 year age class, hypoxylon cankers were often located high up on the main stem of an infected tree. In these cases the canker girdled the main stem of the infected tree, killing first the crown and subsequently the remainder of the tree. Overall tree mortality caused by hypoxylon canker (1 to 2 percent of the trees) was similar to that previously reported (Anderson and Anderson 1968).

Results and Discussion - Ottawa National Forest

On the Ottawa National Forest we sampled 3 stands in the 20 to 39 years age class, 16 stands in the 40 to 59 class, and 6 stands in the 60 years and older class. A total of 814 aspen trees were examined on 50 plots in 25 stands. Eighteen stands had quaking aspen and seven had quaking and bigtooth aspen (Table 3). Basal area of living trees ranged from 37 to 137 square feet per acre and was generally similar to that found on the Nicolet. Site index ranged from 50 to 75 with the highest average sites in the youngest age class.

Disease Incidence on Live Trees

Disease incidence was not related to species composition or site index (Table 4). Overall, individual disease incidence was low for all stands combined. Hypoxylon canker incidence was similar in all age classes, and white trunk rot was most prevalent in the older stands. In stands 60 years or older, white trunk rot infections ranged from 8 (stand 149-8) to 42 (stand

10-10) percent of the trees, with an average of 18 percent. Because of hidden decay, about 36 percent of the trees 60 years and older probably contain some rot.

Nectria canker was most common in stands between 40 and 59 years old. In this age class, three stands (stands 19-28, 249-9, 227-48) had 10 percent or more of the trees infected. Although nectria canker does not usually kill trees directly, it does predispose trees to wind breakage. The incidence of seams increased with stand age but was still at a low level. The percent of trees with dead tops was similar in all three age classes and averaged 3 percent for all age classes combined. About half the dead tops were caused by hypoxylon canker.

Disease Incidence on Dead Trees

Eleven percent of the sampled trees were dead. Tree mortality was significantly different (P=0.05) between the youngest age class (15 percent) and the 40 to 59 year class (12 percent), but it was not significantly different between the middle and older age classes (11 percent). Dead trees had a smaller average diameter than live trees in all but three stands. The same predisposition to pest problems by suppression appeared to be occurring on the Ottawa as on the Nicolet. Another similarity was that the only pathogen commonly associated with dead trees was hypoxylon canker. Following is a summary of mortality factors identified on the Ottawa:

Age Class	No. Dead Trees	Cause of Death: Hypoxylon Canker	Windthrow	Broken Off	Other	Unknown
years		percent *				
20-39	30	3	0	30	37	30
40-59	54	15	7	54	11	13
≥ 60	18	17	0	50	11	22
Total or Average	102	12	4	46	19	20

* totals may not equal 100 percent due to rounding

As on the Nicolet, stem breakage was the most prevalent cause of tree mortality. Tree mortality caused by hypoxylon canker increased with stand age, but was generally lower than on the Nicolet. The large percentage of trees in the "Other" category for age class 20 to 39 was the result of mortality due to suppression in one stand.

Overall Disease Incidence on the Nicolet, Ottawa and Superior National Forests

The following tabulation summarizes disease incidence by age class for the three forests surveyed in 1981 and 1983:

Age Class	Forest	Hypoxylon Canker	Nectria Canker	White Trunk Rot	Butt Rot	Seam	Dead Top
years		percent					
20-39	Nicolet	3	1	3	1	0	1
	Ottawa	2	1	2	0	1	3

	Superior	3	1	4	1	1	1
40-59	Nicolet	5	1	6	1	2	5
	Ottawa	2	5	7	1	2	3
	Superior	1	1	18	2	4	4
≥ 60	Nicolet	1	13	14	0	10	3
	Ottawa	1	0	18	0	5	3
	Superior	1	1	35	1	4	7

White trunk rot was the most common disease of aspen on all three National Forests and its incidence increased as stand age increased. Overall, disease incidence was low, except for white trunk rot in the middle age class on the Superior and in the older age class on all three Forests.

Conclusions and Recommendations

Based on survey results from three National Forests, the primary disease problem in aspen stands 40 or more years old was white trunk rot. To reduce losses from this disease, land managers should adopt the following management practices:

1. Harvest aspen stands on a 50 to 60 year rotation, regardless of site index, except where survey results indicate that less than 5 percent of the trees have white trunk rot at age 50. In the latter situation, cutting can be deferred for at least 10 years, at which time the stand should be re-evaluated.
2. Maintain fully stocked stands to facilitate natural branch pruning and thus reduce the number of potential disease entry courts.
3. Avoid wounding trees in order to minimize injuries that provide entry courts for decay fungi.

Stem breakage was associated with more tree mortality on the three

Forests than any other factor that was identified. The reason for this breakage is unknown because it was not associated with an identifiable disease or insect problem. Hypoxylon canker was the second most commonly identified cause of tree mortality, but its overall impact within a stand was minimal. Maintaining fully stocked stands, as indicated above, will help reduce the incidence of hypoxylon canker.

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Table 1.--Basic stand conditions in aspen stands sampled on the Nicolet National Forest, 1983.

Age Class	Compartment and Stand Number	Average Age	Site Index	Live and Dead Trees Sampled	Dead Trees	Live Trees	Dead Trees	Live BA 1/	Dead BA	Mean DBH Live Trees	Mean DBH Dead Trees
years		years		number	percent	--no.per acre--		--ft^{2}per acre--		-----inches-----	
20-39	183-14	38	74	31	10	140	15	47	4	7.5	6.2
	41-7	25	65	76	7	355	25	31	3	3.9	4.1
	124-18	23	60	29	14	125	20	28	4	6.2	5.7
	161-3	34	70	56	18	230	50	45	5	5.7	4.1
	167-16	31	75	33	18	135	30	31	7	6.1	6.1
Total or average		30	69	225	12	197	28	36	5	5.9	5.2
40-59	35-36	59	70	22	0	110	0	58	0	9.7	0
	71-18	58	65	54	6	255	15	133	4	9.6	6.7
	138-15	51	60	26	8	120	10	60	6	8.9	9.0
	62-14	49	70	37	14	160	25	73	6	8.9	6.3
	10-7	50	64	29	3	140	5	51	1	8.0	6.0
	191-12	47	90	25	4	120	5	103	2	12.3	9.2
	183-28	48	60	34	3	165	5	86	2	9.5	8.6
	104-25	53	68	30	10	135	15	79	10	10.2	10.9
	57-40	48	71	15	13	65	10	54	4	11.9	7.4
	149-6	50	59	18	22	70	20	53	8	11.3	8.9
	117-3	48	80	12	0	60	0	45	0	11.2	.0
	117-17	42	75	16	13	70	10	36	5	9.6	8.7
	44-43	45	60	21	0	105	0	41	0	7.9	.0
	36-17	53	58	19	11	85	10	24	4	6.9	8.7
	72-1	48	60	21	0	105	0	41	0	7.7	.0
	21-8	54	66	20	10	90	10	81	10	12.1	13.4
	36-24	53	70	47	11	210	25	41	2	5.5	3.8
	137-19	46	66	30	3	145	5	47	1	7.3	4.3
	137-31	49	70	29	10	130	15	65	4	9.3	7.1
Total or average		50	67	505	7	123	10	62	3	9.4	7.9
≥60	118-7	60	70	23	4	110	5	68	2	9.9	9.2
	52-14	61	53	27	11	120	15	58	9	9.2	10.2
	94-26	60	70	20	0	100	0	83	0	12.1	.0
	129-37	61	70	27	19	110	25	94	14	12.2	10.0
Total or average		61	66	97	9	110	11	76	6	10.9	9.8

1/ BA = basal area

Table 2.--Incidence of diseases on live aspen trees, Nicolet National Forest, 1983

Stand Number	Trees Sampled	Hypoxylon Canker 1/	Nectria Canker 2/	White Trunk Rot 3/	Butt Rot	Seam	Dead Top
	----------number trees----------						
Age Class 20-39							
183-14	28	2	0	0	1	0	2
41-7	71	1	0	0	0	0	1
124-18	25	2	0	3	0	0	2
161-3	46	0	1	2	0	0	1
167-16	27	1	0	0	0	0	1
Total	197	6	1	5	1	0	7
Percent incidence±$S_{\bar{x}}$		3.0±1.2	0.5±0.1	2.5±1.1	0.5±0.1	0	1.0±0.7
Age Class 40-59							
35-36	22	0	0	0	0	0	0
71-18	51	0	0	6	0	2	0
138-15	24	3	0	2	1	1	4
62-14	32	0	0	0	0	0	1
10-7	28	0	0	0	0	0	0
191-12	24	0	0	7	0	1	0
183-28	33	2	0	2	1	1	2
104-25	27	1	1	1	0	0	1
57-40	13	1	0	0	0	0	3
149-6	14	1	2	1	1	2	1
117-3	12	0	0	3	0	1	0
117-17	14	0	0	0	0	0	0
44-43	21	3	1	0	0	0	4
36-17	17	2	1	0	0	0	0
72-1	21	0	0	0	1	0	0
21-8	18	2	0	2	0	2	2
36-24	42	8	1	2	0	0	2
137-19	29	0	0	2	0	0	0
137-31	26	0	0	1	1	1	2
Total	468	23	6	29	5	11	22
Percent incidence±$S_{\bar{x}}$		4.9±1.0	1.3±0.1	6.2±1.2	1.1±0.5	2.4±0.7	4.7±1.0
Age Class $\geq$ 60							
118-7	22	0	0	0	0	3	0
52-14	24	0	1	2	0	2	1
94-26	20	1	2	5	0	2	1
129-37	22	0	8	5	0	2	1
Total	88	1	11	12	0	9	3
Percent incidence±$S_{\bar{x}}$		1.1±1.1	12.5±3.8	13.6±3.9	0	10.2±3.4	3.4±2.0

1/ Hypoxylon mammatum (Wahl.) Mill.
2/ Nectria galligena Bres.
3/ Phellinus tremulae (Bond.) Bond.et Boriss

Table 3.--Basic stand conditions in aspen stands sampled on the Ottawa National Forest, 1983

Age Class	Compartment and Stand Number	Average Age	Site Index	Live and Dead Trees	Dead Trees	Live Trees	Dead Trees	Live BA 1/	Dead BA	Mean DBH Live Trees	Mean DBH Dead Trees
years		years		number	precent	-no.per acre-		-ft^2 per acre-		---- inches ----	
20-39	30-1	37	70	46	11	205	25	79	8	7.6	7.2
	50-1	35	70	122	20	490	120	71	7	5.0	3.1
	70-7	34	75	30	3	145	5	52	1	7.2	3.4
Total or average		35	72	198	15	280	50	67	5	6.6	4.6
40-59	127-22	53	65	28	14	120	20	66	6	9.7	7.4
	159-8	56	60	20	15	85	15	38	6	8.7	8.4
	19-28	49	73	17	12	75	10	52	4	10.8	8.2
	150-3	46	60	20	0	100	0	37	0	9.3	0
	48-5	59	60	25	12	110	15	63	7	9.8	8.7
	172-10	58	60	48	19	195	45	72	9	8.0	5.8
	82-7	58	60	23	9	105	10	84	4	11.9	8.4
	80-30	48	58	44	7	205	15	95	2	9.0	4.9
	123-17	57	60	39	8	180	15	66	6	7.9	8.4
	123-27	47	50	20	10	90	10	45	5	9.0	9.4
	129-18	56	50	25	4	120	5	48	1	7.4	6.0
	249-9	47	72	35	17	150	25	71	15	9.0	9.5
	220-6	57	74	19	0	95	0	60	0	10.5	0
	227-48	46	64	31	6	145	10	71	4	9.2	8.1
	120-3	51	65	24	25	90	30	54	16	10.0	9.9
	249-8	47	69	30	30	105	45	52	17	9.2	7.9
Total or average		52	63	448	12	123	17	61	6	9.3	7.9
≥60	10-10	80	68	31	16	130	25	137	12	13.6	9.3
	131-6	66	64	30	10	135	15	67	5	8.6	7.5
	92-8	62	73	14	21	55	15	66	16	14.7	13.9
	149-8	65	55	27	7	125	10	45	3	7.9	7.1
	71-22	65	64	20	15	85	15	66	11	11.1	10.6
	70-29	85	65	46	4	220	10	91	2	8.5	5.5
Total or average		71	65	168	11	125	15	79	8	10.7	9.0

1/ BA = basal area

Table 4.--Incidence of diseases on live aspen trees, Ottawa National Forest, 1983

Stand Number	Trees Sampled	Hypoxylon Canker	Nectria Canker	White Trunk	Butt Rot	Seam	Dead Top
		number trees					
Age Class 20-29							
30-1	41	1	0	2	0	1	3
50-1	98	0	0	0	0	1	0
70-7	30	2	1	2	0	0	2
Total	169	3	1	4	0	2	5
Percent incidence±$S_{\bar{x}}$		1.8±1.0	0.6±0.6	2.4±1.2	0	1.2±0.8	3.0±1.3
Age Class 40-59							
137-22	24	0	1	2	0	0	0
159-8	20	0	1	1	0	0	0
19-28	17	0	3	0	0	0	0
150-3	20	1	1	2	0	0	2
48-5	25	0	0	1	0	0	1
172-10	39	3	0	3	0	0	3
82-7	23	0	0	1	0	1	0
80-30	41	0	0	6	1	1	0
123-17	36	0	3	2	0	0	1
123-27	18	1	1	1	0	0	1
129-18	24	0	2	1	0	2	1
249-9	30	0	3	1	0	0	1
220-6	19	0	1	1	0	0	0
227-48	29	0	3	1	0	1	1
120-3	18	2	0	3	1	1	1
249-8	21	0	1	1	0	0	1
Total	404	7	20	27	2	6	13
Percent incidence±$S_{\bar{x}}$		1.7±0.7	5.0±1.1	6.7±1.3	0.5±0.4	1.5±0.6	3.2±0.9
Age Class ≥ 60							
10-10	26	0	0	11	0	0	0
131-6	27	0	0	5	0	1	2
92-8	11	0	0	1	0	0	0
149-8	25	0	0	2	0	1	0
71-22	17	1	0	2	0	2	1
70-29	44	1	0	6	0	3	2
Total	150	2	0	27	0	7	5
Percent incidence±$S_{\bar{x}}$		1.3±0.9	0	18.0±3.5	0	4.7±1.8	3.3±1.5